Release Criteria Guidance

- Committee developed set of questions needing answers
- David Weitzman organized questions into rough outline
- Some of you submitted program documents and white papers from your sites
- David and I made first attempts to extract answers from your documents

Release Criteria Guidance

- Very rough first draft
  - Many questions unanswered
- Please send additional information to
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  - With cc to David.Weitzman@eh.doe.gov

Release Criteria Workgroup

Guidance for Criteria, Characterization, and Remediation and Handling For Release of Beryllium-Contaminated Items, Equipment, Facilities, Areas, and Waste

Questions are in "Arial" font
Discussions are in "Times New Roman" font

OUTLINE

1. BACKGROUND

On December 8, 1999, the Department of Energy (DOE) published 10 CFR 850, a final rule to establish a chronic beryllium disease prevention program (CBDPP) to

- reduce the number of workers currently exposed to beryllium in the course of their work at DOE facilities managed by DOE or its contractors,
- minimize the levels of, and potential for, exposure to beryllium, and
- establish medical surveillance requirements to ensure early detection of the disease.

On January 4, 2001, DOE issued an implementation guide to assist line managers in meeting their responsibilities for implementing the CBDPP. The guide described methods and techniques that DOE considers acceptable in complying with 10 CFR 850.

Since that time, as DOE and its contractors have implemented the various portions of 10 CFR 850, numerous questions about "release criteria" have been raised that were not answered in the implementation guide. In response, DOE formed a release criteria workgroup to develop additional guidance addressing the release of beryllium-contaminated items, equipment, facilities, areas, and waste. The best practices and lessons learned from throughout the DOE complex have been compiled in this guidance document under three broad categories:

- Release Criteria
- Characterization of Beryllium Contamination
- Remediation and Handling

2. RELEASE CRITERIA

2.1 Release Limits for Real Estate

10 CFR 850 specifies release criteria for "equipment or other items," but it does not specify release limits for facilities and space (i.e., real estate). This gives rise to several questions:

- Will one comprehensive beryllium release limit (e.g., 0.2 µg/100 cm^2) be considered the acceptable surface contamination level for all situations?
- Will one comprehensive airborne beryllium contamination limit (e.g., 0.2 µg/m^3) be considered the acceptable airborne contamination limit for all situations?
- If not, what new air and surface release criteria levels need to be developed for different situations such as:
  - Release of real estate to outside DOE,
  - Continued use of real estate by DOE,
  - Access to space by DOE workers, DOE beryllium workers, DOE beryllium-associated workers including sensitized or diseased workers, and
  - Access to space by the public?

At Rocky Flats, "Kaiser-Hill has made a management decision not to release beryllium-contaminated equipment or other items to the general public except on a case-by-case decision basis. Kaiser-Hill ESS, Legal, and RISS property management personnel SHALL approve and define requirements for, on a case-by-case basis, the release of potentially contaminated equipment or other items to the general public."

"When surface sampling is used to fully characterize work areas, the KCP uses the following graded approach to statistically determine the presence of beryllium. If previous knowledge and initial sampling indicate that the area is clean, then test results from a maximum of 22 samples, all less than 1.0 micrograms per 100 square centimeters, will be sufficient to state that the area is free from beryllium contamination. This is based on a 0.90 assurance and 90% confidence levels. If the area is a known beryllium processing area and initial sampling indicates that the area is not clean, then a maximum of 59 samples, all less than 1.0 micrograms per 100 square centimeters, will be required to state that the area is free from beryllium contamination. This is based on 0.95 assurance and 95% confidence levels."

2.2 Beryllium Hazard Levels

What levels on surfaces and in the air constitute beryllium contamination?

2.2.1 Beryllium Contamination Definitions *(per Elton Hewitt)*

No Contamination: Surface beryllium not detected at 0.01 µg/100 cm^2

Detectable Contamination: Surface beryllium > 0.01 µg/100 cm^2

Contaminated Equipment: Surface beryllium > 0.2 µg/100 cm^2

Detectable Airborne: Airborne beryllium > 0.01 µg /m^3

Action Level Airborne: Airborne beryllium > 0.2 µg /m^3

OSHA Level: Airborne beryllium > 2.0 µg /m^3

2.2.2 Bulk Sampling at PNNL *(per John Piatt)*

PNNL collected four bulk samples in the top inch of soil, north, south, east and west of the 300 Areas and 3000 Areas. Sampling was restricted to the top inch of soil to characterize the dirt available to become airborne into facilities. The samples were analyzed for beryllium by DataChem Laboratories in Salt Lake with a reporting limit of 0.1 µg/g.

The four bulk samples from around the perimeter of the 300 area were:
- North: 0.28 µg/g or ppm
- South: 0.29
- East: 0.28
- West: 0.24

with an average beryllium concentration of 0.27 ppm.

The four bulk samples from around the perimeter of the 3000 area were:
- North: 0.28 µg/g or ppm
- South: 0.19
- East: 0.32
- West: 0.38

with an average beryllium concentration of 0.29 ppm.

The overall average concentration of 0.28 ppm is significantly lower than the United States Geological Service (USGS) and Department of Ecology data, which indicates that beryllium concentrations in soil are 1-2 mg/kg (ppm). However, their samples are usually taken at depths of 2-3 feet, which may affect the concentration.

PNNL weighed the net weight of dirt on wipe samples collected in areas with visible dust and dirt. The average weight on 6 samples was 0.041 g. Using an overall average of 0.28 ppm background beryllium, one can estimate the background expected on wet wipes of dirt as follows:

0.28 µg/g x 0.041 g = 0.01µg

This indicates that the contribution of background beryllium in wipe samples at Hanford is small.

Using the ACGIH TLV-TWA of 10 mg/m^3 for inhalable particulates (particles not otherwise classified) to represent significant airborne dust levels, the airborne concentration of beryllium using 0.28 µg/g as the background beryllium concentration would be

$$0.01\ g/m^3 \times 0.28\ \mu g/g = 0.003\ \mu g/m^3$$

This is less than a third of the beryllium concentration noted on Hanford medical work restrictions of beryllium-affected workers (not to exceed 0.01 µg/m^3). If the background concentration was actually 1-2 ppm, as reported by USGS and the Department of Ecology for surrounding areas, airborne concentrations could reach or exceed the level noted in work restrictions. Particle sizing of airborne dust samples prior to analysis would be necessary to determine beryllium levels in the fraction of inhaled particulates that are of respirable size.

2.2.3 Beryllium Concentrations in Alloys and Other Materials

Is it feasible to determine a concentration of beryllium in alloys or other materials below which the amount of beryllium in the alloy or material is not sufficient to cause a beryllium hazard? If feasible,

- For surfaces, should the concentration be set to ensure that surface levels of beryllium are <0.2 µg/100 cm^2, <0.01 µg/100 cm^2, or less than some other surface concentration level?
- For air, should the concentration be set to ensure that surface levels of beryllium are <0.2 µg/m^3, <0.01 µg/m^3, or less than some other air concentration level?

2.2.4 Operational Rule *(BWXT Y-12)*

"The surface level of 0.2 µg/100 cm^2 beryllium is considered to be exceeded for a surface being evaluated when:

- A single sampling result representing the surface exceeds this level or
- The average plus three standard deviationsw of at least 30 random samples that represent the similar surface type exceed this level."

2.3 Managing Beryllium Hazards in Facilities

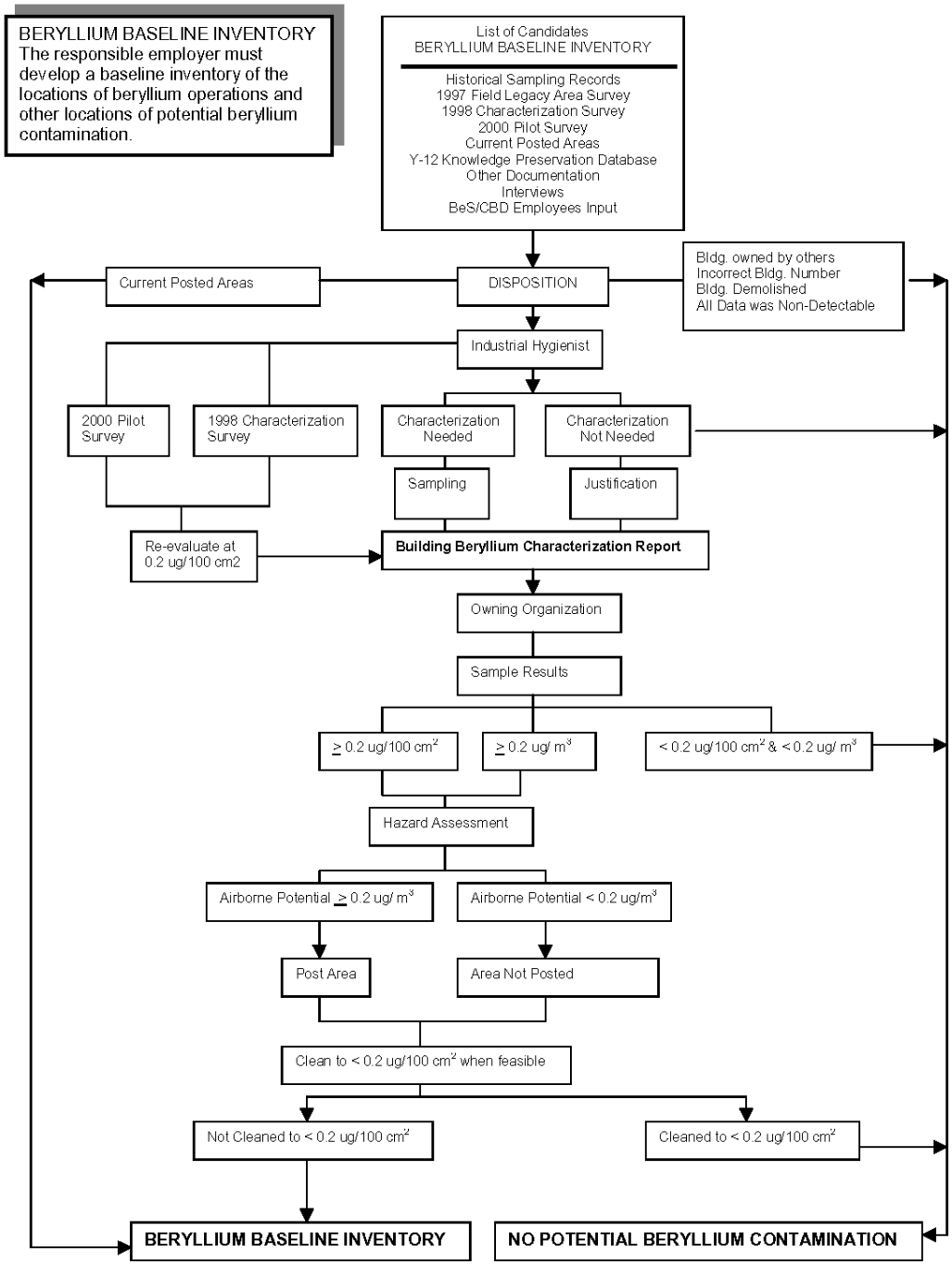
When should a facility be added to a beryllium inventory based on the following past or current information:

- When someone thinks beryllium was kept or used there,
- When we have verified that it contained beryllium,
- When it is known that beryllium processing occurred there,
- When we have analyzed measured past air or surface contamination levels, or
- When we have measured current air or surface contamination levels?

Most sites use a combination of historical knowledge of past processes, records of previous sampling results, employee (and former employee) interviews, professional judgment, and current air and surface sampling.

Should facilities with only potential for past beryllium contamination be treated differently from facilities with current potential for beryllium contamination?

The Y-12 National Security Complex uses a flow chart to aid in making this inventory determination:


BERYLLIUM BASELINE INVENTORY
The responsible employer must develop a baseline inventory of the locations of beryllium operations and other locations of potential beryllium contamination.
List of Candidates
BERYLLIUM BASELINE INVENTORY
Historical Sampling Records
1997 Field Legacy Area Survey
1998 Characterization Survey
2000 Pilot Survey
Current Posted Areas
Y-12 Knowledge Preservation Database
Other Documentation
Interviews
BeS/CBD Employees Input
Current Posted Areas
DISPOSITION
Bldg. owned by others
Incorrect Bldg. Number
Bldg. Demolished
All Data was Non-Detectable
Industrial Hygienist
2000 Pilot Survey
1998 Characterization Survey
Characterization Needed
Characterization Not Needed
Sampling
Justification
Re-evaluate at 0.2 ug/100 cm2
Building Beryllium Characterization Report
Owning Organization
Sample Results
≥ 0.2 ug/100 cm2
≥ 0.2 ug/ m3
< 0.2 ug/100 cm2 & < 0.2 ug/ m3
Hazard Assessment
Airborne Potential ≥ 0.2 ug/ m3
Airborne Potential < 0.2 ug/m3
Post Area
Area Not Posted
Clean to < 0.2 ug/100 cm2 when feasible
Not Cleaned to < 0.2 ug/100 cm2
Cleaned to < 0.2 ug/100 cm2
BERYLLIUM BASELINE INVENTORY
NO POTENTIAL BERYLLIUM CONTAMINATION

2.4 Situations Where Sampling Is Needed

What are the triggers indicating that sampling is needed:

- To determine if a pass/fail standard is met,
- To establish work practices,
- To perform initial characterization of an area,
- To establish boundaries for posting areas,
- For choosing personal protective equipment?
- All facilities and equipment where past or current usage of beryllium is possible, or only:
  - ◊ Where beryllium was stored,
  - ◊ Where beryllium was used,
  - ◊ Where beryllium was used in production,
  - ◊ In areas of known past surface contamination,
  - ◊ In area of known past airborne contamination?

2.5 Sampling Strategy

What needs to be sampled? Do we sample beryllium-contaminated items, equipment, facilities, areas, waste, other?

What types of samples are needed? Do we take air, surface, bulk samples?

Where do we sample? Do we sample routine work areas, rarely accessed overhead areas, enclosed systems?

At the Y-12 site, "smear samples will be collected using procedure *Industrial Hygiene Surface Sampling for Metals Protocol.* Characterization of beryllium surface contamination will be conducted at locations identified on the drawings or using random number tables. For the evaluations, the following three similar surface types will be sampled at each randomly generated location:

- Floors,
- Equipment surfaces such as desks, shelves, machinery and process equipment that would be directly contaminated from beryllium operations, and
- Horizontal surfaces such as window ledges, structural steel, conduits, light fixtures, and ventilation equipment that would be indirectly contaminated by beryllium operations.

If a similar surface type is not at the randomly generated location, the evaluator will:

- Used a substitute randomly generated location to sample that surface or
- Skip the location missing a surface and sample all surfaces at a substitute randomly generated location. The survey team may need to go to more than one substitute location to find a location with the similar surface type.

A safe sampling location within 10 feet of the randomly generated point may be used. Use an alternate random sampling location noted on the drawing if each of the three homogeneous surfaces is not present at a location. Due to safety and logistic concerns, sampling above 8 feet will not be performed. These elevated surfaces are considered

guarded by location, and will be characterized as needed as part of individual projects or work packages. Potential sample locations will be identified within each characterization area group. A random sample location is defined as a point within a 10-ft radius selected in an unbiased manner from a population of points with an equal probability of selection."

What statistical concerns must be addressed to assure that sampling data is sufficiently representative of contamination conditions?

2.6 Sampling Methods

2.6.1 Surface contamination

What are acceptable accuracy, sensitivity, precision, consistency, reliability, etc., of swipe test methods?

What would constitute acceptable comparability of results between different acceptable swipe test methods? Can both wet and dry methods be acceptable?

"The rule only suggests a type of surface sampling method, wet swipes. Sites with the approval of their NNSA/DOE field organizations are free to use any method they deem appropriate. However, all sites can use the same surface contamination limits. If sites use different sampling methods with different collection efficiencies, their results will not be comparable with the same criteria without a correction factor. A site using dry swiping and releasing 0.2 μg/100 cm^2 is potentially equivalent to a site using wet swiping and releasing at a higher level because of the difference in collection efficiency. When different sampling methods are used, different standards need to be applied."

At ETTP, "the sampling method uses moistened mixed cellulose ester filter discs (atomic absorption filters) and the smearing of an area of 100 cm^2 using disposable templates."

"LLNL presently uses the least conservative sampling method, dry swiping, to measure surface beryllium contamination and has no local guidelines on how to swipe for beryllium, where to sample or how many samples to collect."

At the Kansas City Plant, industrial hygiene staff "collect samples on methyl alcohol soaked cloths."

What are acceptable accuracy, sensitivity, precision, consistency, reliability, etc. of alternative surface contamination measurement methods (i.e., vacuum, sticky paper, etc.)?

Should DOE refine current swipe test methods or develop new methods?

Dose DOE need to standardize swipe method techniques?

2.6.2 Airborne contamination

What are acceptable accuracy, sensitivity, precision, consistency, reliability, etc., of airborne contamination test methods?

How should sampling results be reported in quantitative and qualitative terms:

- At the laboratories' level of detection,
- Between the laboratories' level of detection and level of quantitation,
- At or above the laboratories' level of quantitation
- With sampled areas and volumes reported in addition to concentrations in 100 cm^2 and m^3,
- Out to how many significant digits?

2.7 Actions

Should actions be initiated when we find only measurable beryllium surface contamination levels but no measurable airborne beryllium levels?

3. CHARACTERIZATION

3.1 Methods

Which available published or informally adopted methods are acceptable for swipe tests?

What alternative methods exist for surfaces (e.g., vacuum, sticky paper, etc.)?

What methods exist for determining natural versus manmade beryllium in soils or other environmental samples such as plants?

What methods are acceptable for characterizing airborne beryllium?

What are appropriate methods for analysis of samples, particularly for complete digestion of all beryllium compounds, consistent ICP wavelengths, etc.?

3.1.1 Swipe Tests at the East Tennessee Technology Park *(per Ted Helms)*

Industrial hygiene (IH) technician(s) under the direction of a Certified Industrial Hygienist (CIH) collect beryllium smear samples. The CIH determines the specific sample areas and the appropriate number of samples to be taken. Photos may be taken of sample locations using a digital camera, with the exception of areas in which photos are prohibited because of classification restrictions.

The sampling method uses moistened mixed cellulose ester filter discs (atomic absorption filters) and the smearing of an area of 100 cm^2 using disposable templates. In some sample locations because of configuration of the surfaces, it is not possible to use a template, and smear areas are estimated. The materials and equipment used include the following:

- Whatman No. 41 or 42 filter media
- Sample bottles or vials with screw-on caps
- Disposable 100 cm^2 templates
- Disposable latex gloves
- Sample identification labels
- Sealable plastic bag for sample storage/shipment
- Demineralized or deionized water
- Beryllium smears—location field sampling form
- Chain of custody forms
- Personal protective equipment required for entrance into the sample locations
- Digital camera, diskettes, and photo-log worksheet

Sample collection protocol:

1. Unique sample numbers and labels are obtained.

2. Sample bottles or vials with screw-on caps are obtained. Appropriate labels are attached to each bottle. The preloaded and prelabeled bottles or vials are taken to the area to be sampled.
3. When multiple samples are taken, a floor plan or a rough sketch of the area to be smear sampled is used.
4. Appropriate personal protective equipment is donned (e.g. safety glasses, safety shoes, etc.) based on any special entry requirements for the area in which samples are to be collected.
5. A new set of clean disposable impervious gloves is worn for each sample to handle filters. This is required to avoid contamination of the filter by previous samples (and the possibility of false positives), and to prevent cross contamination.
6. Each filter is withdrawn using glove-covered fingers or clean tweezers. The filter media is moistened with distilled/demineralized water.
7. To determine the concentration of contamination (in micrograms of agent per area), it is necessary to record the area of the surface wiped. A clean, unused 100 cm^2 template is placed over the area to be sampled. If the use of a template is impractical because of surface configuration, a 100 cm^2 area is visually estimated. If the area sampled is less than 100 cm^2, the percentage of surface area is estimated and recorded.
8. Firm pressure is applied and sampling pattern is used, that should completely cover the interior of the 100 cm^2 template. Start at the outside edge and progress toward the center of the surface area by wiping in concentric squares of decreasing size.
9. The following is an example pattern for a square template:
    - Start at the top left corner, and wipe down to the bottom of the template.
    - Wipe to the right approximately one filter width, then wipe up to the top of the template.
    - Wipe to the right approximately one filter width, then wipe to the bottom of the template.
    - Continue this pattern until the 100 cm^2 area has been wiped.
10. Without allowing the filter to contact any other surface, the media is folded (half or quarters) with the sample side inward, and the filter is placed completely inside a uniquely identified sample bottle and is sealed with the screw-on cap.
11. The number of the sample location is noted on the floor plan or sketch of the equipment being sampled.
12. Information on the data sheets is completed including building number, date, sample number, sample location, time, surface texture, type of surface material, diskette and photo number (if applicable), and any further description. It is noted whether the entire template is used or an estimate of the percentage of the full template sampled is given.
13. At least one industrial hygiene trip blank filter treated in the same fashion, but without wiping, is submitted for each sampled area. A minimum of 5%, or at least

two field blanks per sample set, is submitted for analysis along with the smear samples.

14. Duplicate samples, which are taken from adjacent areas of similar surface characteristics using side by side templates, are taken approximately every twenty samples. These samples are part of quality control submittals to the analytical laboratory.
15. Each used template is placed in a waste bag or container.
16. Each disposable glove is removed and placed in a waste bag or container.
17. The location of the sample is documented and may include photos. Documentation includes required notations on the sample including surface texture, type of surface material, part or container description applicable, and whether the template is used or the 100 cm^2 area is estimated.
18. After all desired samples are collected, the sample bottles/vials are placed in a clean, sealable plastic bag. A warning label "possible beryllium contamination" or equivalent, is applied to the bag exterior.
19. Upon completion of the sampling, personal protective equipment is doffed as required to exit the area where the sample(s) are collected. Waste materials are disposed of in an appropriate manner.
20. The "Chain of Custody" form is completed and the smear samples and blanks are sent to the laboratory coordinator for analysis. If the samples are not sent immediately to the lab, they are placed in a secure location to insure sample integrity and preclude sample cross contamination.

Sampling forms are completed upon receipt of the laboratory results and the results are reviewed by a CIH. Results along with recommendations are then forwarded to the appropriate parties.

3.2 Sampling

How should swipe samples be taken for different surface situations?

- Readily accessible surfaces, i.e., desks and computer keyboards?
- Relatively inaccessible surfaces, e.g., above suspended ceilings and inside desktop computers?
- Inaccessible surfaces, i.e., interior of pipes and ductwork?

Are there practical or administrative limits to analyzing beryllium samples at some level of radioactive contamination of the sample?

How can these mixed contaminated samples be safely handled?

Should air sampling for beryllium be avoided at some level of radioactive air contamination?

What approach should be used to characterize ventilation systems and areas above 8 feet?

3.3 Statistical Strategies

What are appropriate statistical strategies for characterizing beryllium-contaminated items, equipment, facilities, areas, and waste, including vehicles and heavy equipment entering and leaving contaminated areas, etc.? Should the strategies include consideration of:

- Knowledge of the processes that were the sources of the beryllium?
- Results of previous sampling or results of sampling of similar situations?
- Professional judgment?
- "Batching" surfaces by sampling several surfaces or several pieces of equipment with one filter covering more than 100 cm^2?
- 100% sampling of all potentially contaminated equipment and materials?
- 100% sampling of the air in all potentially contaminated areas?

3.3.1 Surface Beryllium Characterization at the Y-12 National Security Complex

Surface Beryllium Characterization at the U.S. Department of Energy's Y-12 National Security Complex

Date of Issue: March 13, 2001

CAUTION

This document has not been cleared for release
to U.S. Department of Energy contractors or the public.
Further distribution must be authorized by the
Y-12 Plant Technical Information Office.

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EXECUTIVE SUMMARY

The processing of beryllium has been an important part of the Y-12 mission since the 1950s. Fulfilling this mission has required the execution of beryllium processing, research, and storage activities in numerous locations throughout the Y-12 Plant. The dynamic nature of Y-12's mission has resulted in both the physical location and the processes changing frequently. Due to the potential health concerns and the recently issued U.S. Department of Energy (DOE) Chronic Beryllium Disease Prevention Program (CBDPP), an evaluation to identify the presence of beryllium is required to prepare a baseline inventory. This document was developed to present a beryllium characterization plan for evaluating buildings at the DOE Y-12 National Security Complex.

The objectives of the beryllium characterization survey are to: (1) systematically characterize locations of potential beryllium contamination so that a baseline beryllium inventory can be prepared in accordance with the DOE CBDPP (10 CFR 850.20); (2) provide data that can be utilized in conducting the DOE CBDPP beryllium hazard assessments (29 CFR 850.21); and (3) utilize a risk-based approach that is logical and defensible as well as flexible in application.

DEFINITIONS

Active beryllium areas: A functional beryllium area where current beryllium operations are conducted and identified as either a 1) beryllium buffer area, 2) beryllium storage area, 3) beryllium area, or 4) regulated beryllium area.

Beryllium: Beryllium is a grayish white substance with an atomic weight of 9.01. It may be solid or powder form.

Beryllium area: A physical location within a building referenced to a room, machine, or column number.

Characterization area: An area where either beryllium or beryllium compounds were processed or stored based on 1) beryllium process history or 2) historic industrial hygiene sampling data. The area may or may not be administratively controlled through the posting of signs.

Characterization area group (CAG): Combination of one or more characterization areas within a building for evaluation purposes.

Professional judgement: The application and appropriate use of knowledge gained from formal education, experimentation, inference, and analogy. The capacity of an experienced professional to draw correct inferences from data, frequently on the basis of experiences, analogy, and intuition.

Random samples: Samples selected from a population such that each sample item has an equal (e.g., unbiased) probability of being selected.

Similar surface type: A term used to describe similar surfaces within a characterization area group from which a statistically valid group of random samples are collected. Similar surface types include floors, equipment, and horizontal surfaces.

OPERATIONAL RULE

For purposes of this evaluation, the surface level of 0.2 $\mu g/100cm^2$ beryllium is considered to be exceeded for a surface being evaluated when:

a) A single sample result representing the surface exceeds this level or
b) The average plus three standard deviations of at least 30 random samples that represent the similar surface type exceed this level.

1. Purpose and Introduction

The purpose of this plan is to document a scientifically based sampling plan and approach for determining beryllium levels at the U.S. Department of Energy (DOE) Y-12 National Security Complex in Oak Ridge, Tennessee.

The processing of beryllium has been an important part of the Y-12 mission since the 1950s. Fulfilling this mission has required the execution of beryllium processing, research, and storage activities in numerous locations throughout the Y-12 Plant. The dynamic nature of Y-12's mission has resulted in both the physical location and the processes changing frequently. Due to the potential health concerns and the recently issued U.S. Department of Energy (DOE) Chronic Beryllium Disease Prevention Program (CBDPP), an evaluation to identify the presence of beryllium is required to prepare a baseline inventory. This document was developed to present a beryllium characterization plan for evaluating buildings at the DOE Y-12 National Security Complex.

1.1. Historical Beryllium Use at Y-12

Components containing beryllium or beryllium compounds have been used in research and development, testing, and manufacturing operations since the 1950s. Depending upon the specific operation or process involved, a potential may still exist for small amounts of beryllium or beryllium-containing compounds to remain on equipment, building surfaces, or other surfaces. To ensure worker protection and public safety, there has been an ongoing program to monitor airborne and surface beryllium levels. Historical beryllium data provides information as to the past levels of beryllium found in air and on surfaces and along with process knowledge and similar information, identifies areas where residual contamination may still exist.

1.2. Data Limitations

Over 300,000 smear and air monitoring results from the 1950's to present day have been reviewed. While historic beryllium data provide relevant information regarding past levels, they vary widely in usefulness for the current evaluation because analytical detection limits, QA/QC practices, sampling and analytical procedures, and record keeping and documentation requirements themselves have changed.

Key issues affecting the usefulness of the historic beryllium data include (1) the industrial processes associated with an area have changed since the last beryllium activities were documented, (2) building renovations may have occurred, and (3) the specific location or activity sampled may not have been adequately documented. *However, the data does provide some useful information such as where beryllium may have been used and the order of magnitude of past contamination levels.*

1.3. Established Practices and Precedents

To support earlier beryllium characterization efforts, the Industrial Hygiene (IH) department developed and implemented a statistically-based sampling and analysis approach to provide sampling strategies and practices for the characterization (*Y-12 Industrial Hygiene Beryllium Sampling Strategy,* Y/TS-1763 Rev. 1, March 21, 2000). This approach, based upon accepted statistical practices, was developed for specific buildings and areas with active beryllium activities.

2. Objectives

The objectives of the survey are to:

1. Systematically characterize locations of potential surface beryllium contamination so that baseline beryllium inventory can be prepared in accordance with the DOE CBDPP (10 CFR 850.20).
2. Provide data that can be utilized for DOE CBDPP beryllium hazard assessment (29 CFR 850.21).
3. Utilize a risk-based approach that is logical and defensible as well as flexible in applications.

3. Survey Technical Approach

The technical approach for evaluating the buildings is designed to be systematic and straightforward. The basic steps of the approach are described in the following five primary tasks:

Task 1. Identify Characterization Areas using Historic Data and Interviews
Task 2. Establish the Characterization Area Groups (CAGs)
Task 3. Develop the Building Specific Sampling Strategy
Task 4. Implement the Sampling Strategy
Task 5. Prepare the Characterization Report

Task 1. Identify the Characterization Areas using Historic Data and Interviews. The objective of this task is to identify areas where past beryllium operations occurred so that the evaluation includes each suspected characterization area. Key activities include:

- *Compile all known data sets into a single comprehensive population of beryllium data*. This ensures the team that relevant records, buildings, operations, and areas are included within the project scope. Include areas identified on the *Current and Historical Beryllium Areas* list maintained by Industrial Hygiene.

- *Research historic activities that generated the need for sampling.* This ensures that the team has knowledge of past processes and activities including building renovations and changes that could affect past sampling results. Understanding any available information helps the team determine whether any additional characterization work is required. This will be accomplished by reviewing past records and interviewing personnel.

Task 2. Establish the Characterization Area Groups (CAGs). The objective of this task is to establish specific areas for statistical evaluation. Establishing CAGs has two major elements:

- *Sort Characterization Areas by past Sampling Data.* Building specific historical information will be complied if available, which allows information to be sorted by historic sampling results. For each area, available historical data will be evaluated and each individual area can be assigned to one of three categories according to the maximum smear levels indicated. These categories can be used to determine in preparing appropriate sized CAG's. The three suggested categories are:

Category 1: Historical results are non-detectable (less than the limit of quantification at the time of the sample analysis).
Category 2: Historical results range from non-detectable to 5.0 μg/100 cm^2.
Category 3: Historical results are 5.0 μg/100 cm^2 or above.

The result of this task is CAGs based on past data and process knowledge.

- *Group multiple characterization areas.* Categorizing characterization areas by past sampling results provides the evaluator with information as to potential contamination levels that could still possibly exist and serves as a basis for a strategy to evaluate all the areas within a building. By using process knowledge and professional judgement, similarly categorized areas were combined into logical CAGs for evaluation. *Careful consideration will be applied to this task since the results obtained may apply to all areas included in the group regardless of the actual location of samples collected and analyzed.* Factors that may influence grouping of areas include:

  - *Square footage of the group.* Groups composed of Category 1 areas comprise more square footage as the expectation for positive sample data is low. Conversely, positive results are a higher probability for Category 2 and 3 areas, which limited the size of these groups.

  - *Building layout.* Similar groups were logically assembled according to geographical proximity depending upon building size, number of characterization areas in given category, and area location.

The result of this task will be a list of characterization areas grouped together by category, which serve as a foundation upon which a building-specific sampling and analysis plan can be developed.

Task 3. Develop the Building Specific Sampling Strategy. The objective of this task will be to develop a sampling strategy for evaluating each CAG. Assembling groups from similar characterization areas provides a population with similar characteristics that will be systematically evaluated through sampling. This approach is described in the Y-12 Industrial Hygiene Beryllium Sampling Strategy referenced earlier in this document. The dominant sampling approach relies on random sampling for evaluating each group. *The same random approach is applied to every group, regardless of the characterization area categories that comprise the group*. A brief summary of the sampling strategy:

- *Divide each CAG.* Divide each CAG into at least the following similar surface types to ensure a complete and thorough evaluation. The three similar surface types are (1) floors; (2) equipment surfaces such as desks, shelves, machinery and process equipment that would be directly contaminated from beryllium operations; and (3) horizontal surfaces such as window ledges, structural steel, conduits, light fixtures, and ventilation equipment that would be indirectly contaminated by beryllium operations. Additional similar surface types may be evaluated separately, if needed.

- *Sample Collection.* Evaluate each similar surface type within a CAG according to established procedure. Each similar surface type within a CAG is evaluated using a minimum of 30 random samples. This approach, and the computation of the average plus three standard deviations, was chosen so that the evaluators could use the results, regardless of the underlying distribution of the

population being sampled, to estimate the approximate 99th percentile and use it as a basis for making decisions. A summary of the statistical approach is described later in this section.

Collect 30 samples from each of the three similar surface types per CAG. The total number of samples for a given building or building set equals the number of CAGs (regardless of size) × 90 samples/characterization group, not including field blanks.

Professional judgement should also be considered in the collection of random samples within CAGs. Since the samples are chosen at random, it could occur that some characterization areas included within a larger group being sampled could be missed in the random sampling process. If the omission could cause management/worker concerns as to whether the sample fairly represents the population being sampled, the taking of additional random samples in these overlooked areas is acceptable.

A primary advantage of this proposed approach is that it allows for additional or corrective actions to be isolated to the similar surface types. For example, the determination that unacceptable levels of beryllium is present on floors may require a cleaning action and resampling, but would probably not require any action involving other similar surface types in the same CAG (assuming acceptable results were initially obtained).

This sampling approach will be generically applied to each characterization area to ensure that a systematic process is applied in characterizing these areas to achieve the project objectives. The evaluator, however, may have existing knowledge or suspicions about a specific area, piece of equipment, or surface that needs further investigation. Elective (e.g., biased) sampling may be conducted to determine if contamination is present. Professional judgement is applied to the number and location of these samples, and any resulting actions are confined to the area or equipment being evaluated. *It should be noted that this additional sampling is conducted in addition to the statistical sampling approach previously described for similar surface type. There is no statistical confidence implied for surfaces that are represented by elective sampling and these surfaces will not be included in statistical evaluation.*

Summary of Statistical Analysis

To determine an appropriate sample size, a statistical analyst constructed two hypothetical models: one modeling a "good" area where the distribution of possible smear samples was such that none were greater than 0.2 μg/100 cm^2, and the second modeling a "bad" area where 10% of the samples had higher values than 0.2 μg/100 cm^2. The objective was to determine an appropriate sample size and an appropriate sampling statistic to pass the "good" area and flag the "bad" area more than 99% of the time. Four possible statistics were evaluated: (1) the largest value in the sample; (2) the value computed by adding three times the standard deviation of the results to the average; (3) the value computed by adding three times the standard deviation of the results to the average, where the computed standard deviation was corrected for small sample bias; and (4) the value computed by adding "k" times the standard deviation of the results to the average, there "k" is a tolerance interval factor published in statistical tables.

Simulation studies on repeat samples showed that a sample size of 30 and the use of the statistic described in (2) of the previous paragraph provided a high reliability and ease of computation. By taking a sample size of 30 and flagging the area if the average plus three standard deviations exceeds 0.2 μg/100 cm^2, the "good " area is accepted and the "bad" area is flagged more than 99% of the time.

If the population being sampled followed the standard bell-curve or "normal" distribution, and we knew the average and the standard deviation, then 99.86% of the population values would lie below the value computed by taking the average plus three standard deviations. Unfortunately, beryllium sampling results do not follow this theoretical distribution. Instead, distributions of contamination data are almost always skewed to the right, giving more high readings than would be expected from a bell-curve. Work has been done though, notably by Don Wheeler who is internationally known for his work in statistics, to show that regardless of the underlying distribution of results, the value established by the average plus three standard deviations almost always bounds about 99% of the population. Thus, if areas pass the sampling criteria, there is high assurance that only a small fraction of the possible samples fall above 0.2 $\mu g/100$ cm^2, and in fact, about 99% fall below the computed upper limit. Further, because you have a random sampling from the area, you can characterize the population from the sample, making appropriate statistical statements. You might also note that you can be 95% sure that at least 90% of the population will fall below the largest value in the sample of 30. This fact is useful to those who worry that the sample size might be so small as to mis-represent the tail of the distribution.

Task 4. Implement the Sampling Strategy.

Prior to the implementation of this plan, a pre-job briefing will be held with the field staff in attendance to review this plan, logistical issues, and classification issues.

Surface Sampling

Smear samples will be collected using procedure Industrial Hygiene Surface Sampling for Metals Protocol (included in Appendix A). Characterization of beryllium surface contamination conducted at locations identified on the drawings or using random number tables.

For the evaluations, the following three similar surface types will be sampled at each randomly generated location:

- Floors,
- Equipment surfaces such as desks, shelves, machinery and process equipment that would be directly contaminated from beryllium operations, and
- Horizontal surfaces such as window ledges, structural steel, conduits, light fixtures, and ventilation equipment that would be indirectly contaminated by beryllium operations.

If a similar surface type is not at the randomly generated location, the evaluator will:

- Use a substitute randomly generated location to sample that surface or
- Skip the location missing a surface and sample all surfaces at a substitute randomly generated location. The survey team may need to go to more than one substitute location to find a location with the similar surface types.

A safe sampling location within ten feet of the randomly generated point may be used. Use an alternate random sampling location noted on the drawing if each of the three homogeneous surfaces is not present at a location. Due to safety and logistic concerns, sampling above eight feet will not be performed. These

elevated surfaces are considered guarded by location, and will be characterized as needed as part of individual projects or work packages.

Potential sample locations will be identified within each CAG. A random sample location is defined as a point within a ten foot radius selected in an un-biased manner from a population of points with an equal probability of selection.

Air Sampling

Representative personal air sampling will be conducted on field team personnel during surface sampling activities. A minimum of one personal breathing zone sample per day will be obtained during the surface sampling activities. Air sampling will be collected using Industrial Hygiene Personal or Area Air Sampling protocol (included in Appendix A).

Documentation

The documentation associated with characterization will include [1] building floor plans, [2] smear sampling forms, and [3] air sampling forms.

Task 5. Prepare the Characterization Report. The objective of this task is to provide line and program management with prompt and concise reports of the evaluation performed. It is anticipated that most areas evaluated will contain beryllium contamination levels below any immediate levels of concern. However, this cannot be taken for granted and will be confirmed through the sampling and analytical approach previously described. The basic outcomes are:

1. Areas represented by smears that have a beryllium surface level that does not meet the Operational Rule can be excluded from any further concerns or actions.

2. The following activities will be conducted for areas represented by smears that have a beryllium surface level that meets the Operational Rule. Upon receipt of the analytical results, IH will notify the Organization's management in writing regarding [1] the findings and [2] recommendations for continuing operations. IH will support the Organization with developing and implementing corrective measures.

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3.4 Costs

What costs are reasonable? Considerations include:

- Direct analytical costs.
- Staff, materials and other resources for sample collection.
- Number of samples to collect.
- Cost impact due to delays while waiting for sampling results.
- "Batching" several surfaces or several pieces of equipment with one filter that covers more than 100 cm^2.

4. REMEDIATION AND HANDLING

4.1 Waste Disposal

Where can waste and scrap material go for disposal after it is decontaminated?
For items with possible high beryllium contamination remaining within the item, is cleaning the surface below the 10 CFR 850 release criteria level of 0.2 µg/100 cm^2 acceptable for disposal in a standard landfill:

- If it has fixative applied to the surface of the item,
- Has shrink wrap applied over the fixative, and
- The item is labeled?

Is this method still permissible if the surface is not cleaned below 0.2 µg/100 cm² and is disposed of in a standard landfill?
Is this method still permissible if the surface is not cleaned below 0.2 µg/100 cm² and is disposed of in a landfill approved for asbestos waste?
Is sealing of contaminated surfaces or filling structures (pits, trenches, etc) with sealant, i.e., "fixing and abandoning in place," acceptable?

At the Hanford site, "waste management requirements for beryllium waste will generally be the same as for low-level radiological waste. Unique beryllium waste management requirements will be developed for each project in accordance with BHI-EE-10, *Waste Management Plan,* if necessary."

At Rocky Flats, "fixative is acceptable to achieve a contamination level less than or equal to 0.2 µg/100 cm^2 . . . . Waste (solides, sludges, liquids) containing less than 1000 parts per million (ppm) beryllium (less than 0.1%) volumetric will not be managed as beryllium-containing waste."

At Rocky Flats, "40 CFR 61.30 contains the National Emissions Standards for Beryllium as part of the Clean Air Act NESHAP program. Listed sources subject to the beryllium NESHAP include machining and foundry operations that process beryllium ores, beryllium oxides, and any metal alloy containing greater than 5% by weight beryllium. Wastes generated from listed sources are regulated as a beryllium-containing waste when sent off-site for incineration."

4.2 Statistical Protocol for Cleaning

What is an acceptable standard statistical protocol for cleaning surfaces and verifying cleanliness has been achieved?

4.3 Practices for Servicing Vehicles

What are appropriate exposure and contamination control practices for servicing vehicles and heavy equipment entering and leaving contaminated areas?
Consider:

- Type of service,

- Location of service,
- Handling of air filters, oil and other fluids, and
- Cleaning tires or tracks, etc.

What surface contamination level of concern is appropriate, since going down the road the vehicles could acquire beryllium from background dirt?

4.4 Practices for Decommissioning and Decontamination Activities

What are appropriate exposure and contamination control practices for decommissioning and decontamination activities?

At the Hanford site, the industrial hygiene organization participates in the planning phase of projects dealing with demolition of facilities considered "beryllium-suspect." "The IH representative reviews the turnover documentation and participates in the facility walkdown and subsequent health and safety plan (HASP). For beryllium-suspect facilities, the HASP shall address the following:

- Need for additional swipe sampling prior to demolition if the facility baseline does not fully characterize all surfaces or material that will be disturbed during demolition.
- Control measures required to prevent airborne emissions during demolition.
- Personal monitoring and area sampling required during all operations involved in the demolition.
- Required personal protective equipment including respirators for potential beryllium exposures.
- Disposal requirements for beryllium-contaminated waste."

4.5 Practices for Servicing Building Systems

What are appropriate exposure and contamination control practices for repair and maintenance of contaminated building systems such as ventilation systems, elevators, and spaces above suspended ceilings?

4.6 Posting and Labeling

What consideration should be given to posting work spaces that have surface levels of beryllium between non-detectable and the 10 CFR 850 item release criteria level of 0.2 µg/100 cm^2, and between 0.2 µg/100 cm^2 and the 10 CFR 850 housekeeping level of 3.0 µg/100 cm^2?
Should building management and occupants be notified via web broadcasts or labels when buildings or areas contain these beryllium contamination levels?
What restrictions and controls, if any, are needed for beryllium sensitized or diseased workers in buildings with these beryllium contamination levels?
What procedures should be followed to identify or post former beryllium areas that are released for non-beryllium uses?
What wording is appropriate for labeling items released with levels that are detectable but less than the 10 CFR 850 release level of 0.2 µg/100 cm^2?

Consider the impact of labeling and posting contaminated equipment and/or real estate when the 10 CFR 850 release criteria level of 0.2 µg/100 cm² is not exceeded.
How to address future potential liability issues surrounding release of former beryllium areas that are posted?

4.6.1 Posting at the Y-12 National Security Complex

A. Industrial Hygiene Organization

NOTE: Areas that are temporary in nature and require repeated posting and down posting as part of the operations strategy will not be deleted after each down post unless beryllium operations are permanently terminated.

1. Maintain an electronic database that identifies the locations of beryllium buffer areas, beryllium storage areas, beryllium areas, regulated beryllium areas and historical areas.

2. Maintain existing sampling documentation for each facility where beryllium is or has been stored or processed.

3. Validate the electronic database as part of the annual performance feedback.

4. Update the electronic database and characterization records to reflect approved changes received from line management.

B. Line Management/Operations Manager

NOTE 1: Areas may be down posted following Y/TS-1763, *Y-12 Industrial Hygiene Beryllium Sampling Strategy*, when beryllium activities and storage are terminated.

NOTE 2: A characterization survey is not necessary to add an area to the inventory when the area has been previously characterized or the area has not had any historical beryllium processing.

1. Conduct, in conjunction with Industrial Hygiene Organization personnel, appropriate characterization surveys to add or delete areas in a facility.

2. Approve or disapprove the request to add or delete an area.

NOTE 3: Areas that are temporary in nature and require repeated posting and down posting as part of the operations strategy will not be deleted by the beryllium program manager after each down post.

3. Execute the appropriate steps to properly post or de-post the approved area and forward the survey reports, along with the justification for adding or deleting the area to the beryllium program manager.

4.7 Packaging

What are appropriate procedures for packaging, handling, and labeling of beryllium stock, parts, materials, or compounds; and beryllium contaminated equipment, and waste? Considerations include:

- Appropriate labeling for the material, its intended use, and destination.
- Appropriate level of packaging and containment for transportation.

What procedures should be used for transferring relevant records, site history, etc., that pertain to the items?
If destined for disposal, will the chemical activity of the soil or other environmental factors influence the packaging needed for disposal?
What are the labeling requirements for equipment and material released for scrap metal recyclers?

4.8 Dermal Protection

What is the appropriate minimal personal protective equipment for use in the following areas (including PPE for protection against dermal contact considering the increasing concern that dermal contact with beryllium may cause sensitivity):

- Beryllium regulated areas,
- Areas where beryllium levels are between the 10 CFR 850 item release criteria level of 0.2 µg/100 cm^2 and the 10 CFR 850 housekeeping level of 3.0 µg/100 cm^2, and
- Areas where beryllium levels are between non-detectable and the 10 CFR 850 item release criteria level of 0.2 µg/100 cm^2?

What is the appropriate PPE for high-exposure potential activities such as cleaning grossly contaminated hoppers and ducts?

4.9 Subcontractor Considerations

What is the impact of the Davis-Bacon Act on determining which workers perform D&D work and therefore may receive exposure?
Do such subcontractor considerations have a negative impact on the ability to comply with the 10 CFR 850 requirement to minimize the number of workers exposed to beryllium? If so, how can these impacts be addressed?
Doe the potential exist for liability, whereby DOE sites would be responsible for providing lifetime beryllium medical screening to transient construction workers? If so, how can this liability be addressed?